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ABSTRACT

"The purpose of this article is to report a review of the developing empirical literature to explain "expert" teacher behavior, by analogy, from the cognitive psychology expertise literature. Emphasized is a review of the expert-novice cognitive psychology literature, encompassing the research on: chess, and other games; physics, medicine, and other academic disciplines; and a melange of other areas. Also emphasized is the modest but growing, partly ethnographic, partly empirical, expert versus novice teacher research literature, focusing on the public school level, as opposed to the college level. Also addressed are other, traditional, empirical approaches to estimating expertise in teaching including the traditional presage teacher evaluation research. Considered are the qualities of teaching excellence literature, student rating scale teaching qualities correlation and factor analytic literature, the incompetent teacher literature, and finally the classroom teaching effectiveness literature developed primarily in reading and mathematics, including direct instruction and transitions. Thirty-six references are included. (Author/JD)

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EXPERTISE IN TEACHING: EXPERT PEDAGOGUES

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The purpose of this article is to report a review of the developing empirical literature to explain "expert" teacher behavior, by analogy, from the cognitive psychology expertise literature.

Emphasized will be a review of the expert-novice cognitive psychology literature, encompassing the research on: chess, and other games; physics, medicine, and other academic disciplines; and a melange of other areas.

Also emphasized will be the modest but growing, partly ethnographic, partly empirical, expert vs. novice teacher research literature, focusing on the public school level, as opposed to the college level.

Also addressed will be other, traditional, empirical approaches to estimating expertise in teaching including the traditional presage teacher evaluation research. Considered will be the qualities of teaching excellence literature, student rating scale teaching qualities correlation and factor analytic literature, the incompetent teacher literature, and finally the classroom teaching effectiveness literature developed primarily in reading and mathematics, including direct instruction, transitions, etc.

Expert-Novice Cognitive Psychology Literature

In the cognitive psychology literature, exemplified by the seminal studies of de Groot (1965) and Chase & Simon (1973) in chess, and Chi, Feltovich & Glaser (1977) in physics, experts were compared with non-experts in mostly small sample studies, some ethnographic, some experimental, a few survey, on a variety of criteria, i.e., knowledge, recall, speed, reaction time, etc.

These studies have been mainly conducted in two general areas, games, and academic disciplines, as well as in a scattering of other areas. Most of the games research has been conducted in chess, exemplified in studies by de Groot (1965) and Chase & Simon (1973). Much of the academic research has been conducted in physics exemplified in studies like Chi, Feltovich & Glaser (1977), also in medicine, and to a lesser extent in other academic disciplines.

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Follman (1985) synthesized the expert/novice cognitive psychology literature and concluded that there are two foci: One focus is arithmetic estimates derived in different fields of the effort required for the achievement of mastery of a field. Primarily considered are chess and the academic disciplines of medicine and physics. Also examined are some athletic activities in the psycho-motor domain. The best estimate from a synthesis of the findings from these different fields of the effort necessary for mastery of a field is a regimen of about 10 hours per day for 10 years in order to achieve the concensus criterion of mastery, of ca. 50,000 chunks.

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The second focus is a contrast of the differences between experts and novices. The major areas examined are again chess, medicine and physics, along with bridge, computer programming, counseling, designing computer software, circuit drawings, go, mathematics, music, pegity, social science, and writing. Dependent variables include amount of knowledge, meaning, skill, speed, reaction time, memory, recall, structure, and reconstruction.

Additional fields in which expertise has been researched addressed in the paper include algebra, checkers, problem solving, and research.

In the context of mastery, expertise, etc., experts

1. possess more information, both facts and patterns, especially in long-term memory
2. conceptualize more abstractly
3. operate semantically rather than episodically
4. construct more complex schema
5. operate more quickly, both on perception and recall
6. demonstrate more automatization of routines and control processes
7. respond with abstract solution procedures rather than respond determined by the entities in the problem statement
8. think more flexibly
9. manifest marked chunking, with larger chunks
10. manifest clear superiority, about 50% more, in achieving criterion, with structured, meaningful material

The reader must be alerted to the caveat that it is not at all clear that conclusions can be drawn across such a disparate array of areas, research conditions, dependent variables, subjects, and especially small sample sizes, etc. Keeping this caveat in mind we will now proceed to link the expert-novice cognitive psychology literature with the expert-novice teacher literature.

In other analyses Dreyfus & Dreyfus (1986) studied people learning to be drivers, pilots, chess players, and masters of a second language. Dreyfus & Dreyfus (1986) concluded across these classes that the learners go through five stages, Novice, Advanced Beginner, Competence, Proficiency, and Expertise.

Allard & Burnett (19xx) argued that, although there are serious differences between sports activities and cognitive activities, sports experts have cognitive skills similar to those of cognitive experts.

Bloom, et al. (1985) identified 120 young people who had become world class experts in their respective fields by ca. age 35. Studied were pianists, sculptors, swimmers, tennis players, research mathematics, and neurologists. The pianists and swimmers saw themselves as "pianists" and "swimmers", respectively by the age of 12, and the mathematicians saw themselves as mathematicians by the age of 17. Extended hard work, practice, is clearly implicated here. This em-

phasis on practice, experience, brings into focus the enigmatic, confounded relationship of experience and expertise.

One linkage vehicle will be that of teacher rehearsal strategies, i.e., routines, automatization. Routines have a venerable history going at least as far back as 1909 (Bagley, 1909). These strategies embody cognitive psychology information processing principles including mnemonics of mental images and sentences, grouping, ordering, creating hierarchies, rehearsal strategies, etc. Weinstein and Mayer (1986) determined eight main categories of learning strategies with rehearsal heavily implicated in at least two, rehearsal for basic learning tasks and also complex rehearsal strategies.

Expert vs. Novice Teachers: Experts vs. Novice Teacher Research Literature

In the expert vs. novice teacher literature mostly small sample studies, partly ethnographic, partly empirical, "expert" teachers have been compared to non-expert, "novice" teachers, in an exploratory effort to attempt to identify differences, and especially criterial characteristics of "expert" teachers. Central in this effort has been the research of Leinhardt, with Caldenhead (1983), Berliner, and Shulman also directing different, parallel streams of research.

Leinhardt (1983) had 11 expert teachers and 11 observer novice teachers estimate the overlap between the curriculum to which a child had been exposed and the score on a criterion test for each child. Also, four of these teachers and three of these observers were asked to describe their thoughts while doing the overlap task. The estimates of overlap by the experts and the novices were not dissimilar. However, a qualitative analysis indicated that experts had greater understanding of how and why they made their estimates. Experts were also more articulate with their reasons for their estimates.

Leinhardt (1983,a) in a preliminary research, reviewed the early literature that led up to the application of cognitive psychology to cognitive skill in teaching via contrasting experts with novices. Elementary mathematics was the medium. Leinhardt (1983,a) concluded that the expert teacher employed two schemas, one action, and one information. The novice, compared with the expert teacher, used a less effective question, did not have a routine to obtain the information, and did not maintain control of the flow of information.

In another study, Leinhardt (1983,b) identified a group of "expert" teachers whose students had excellent achievement growth scores, and compared them with four student teachers in elementary mathematics. Expert teachers used a three stage core, presentation of information, public shared working out of problems, then interactive and independent seatwork. Experts' activity structures were flexible, could be shifted and pieces interchanged, required little monitoring and required little explanation to carry them out. Again, experts employed an action schema and an information schema. Novices got involved in long presentations and were less routinized.

Leinhardt & Greeno (1984), again in elementary math, contrasted eight expert teachers with four novice, student teachers. Findings were similar to Leinhardt's (1983,b) four activity structure findings. The differences crystallized in consistency, and routinization, with novices spending more time in guided practice and less time in monitored process. Also there were different goals. These three studies apparently were all based on the same subjects.

Leinhardt & Smith (1985), through teaching of fractions, compared three experts and four novices, a sample associated with the three previous studies' sample. In this analysis, the central finding was the wide range of knowledge among the three expert teachers.

Six expert and novice mathematics teachers were compared by Leinhardt & Greeno (1986). Expert teachers again employed a core of activities, used efficient routines, used a large repertoire of routines, and employed similar activities to the four activity structure findings in Leinhardt (1983,b). The experts' lesson was seen as an agenda of action segments. Each segment had a substantive and unique content, a goal structure, and a consistent knowledge base. Novices, on the other hand, mainly displayed a constantly changing pattern in how they taught compared to the experts' well practiced routines.

Leinhardt, et al. (in press) reported that expert teachers used the first days of school to develop and rehearse routines which would enhance instruction. Six teachers who were observed used routines classified into management instructional support, and teacher-student exchange. Leinhardt, et al. (in press) compiled a prescription of initial practices which should be efficacious for experienced and beginning teachers alike.

The aim of Caldenhead's (1983) paper was to explain the rationale for a series of studies investigating teachers' and student teachers' cognitions, to review some of the substantive findings arising from the research, and to raise some related methodological and theoretical issues for discussion. The differences in the cognitions of experienced and beginning teachers, were examined to appreciate the nature and development of teachers' classroom practices. Beginning teachers appeared to lack the conceptual structures or else had simple, undifferentiated structures with which to make sense of classroom life, and did not extract the same kind or level of meaning as experienced teachers. Experienced teachers frequently commented on the following functions; Pacing, Checking Understanding, Balance, Cueing, Attention. Six experienced teachers, six student teachers and six probationer teachers (in their first year of teaching after college training) were studied at various times during the course of a school year, using a variety of methods. Teachers seemed to possess qualitatively different types of information about pupils. Teachers' perceptions could be classified into four main categories: knowledge about pupils in general; general knowledge about particular pupils; specific knowledge about pupils; and knowledge related to diagnostic remediation routines. It seems that beginning teachers start out with very little of any of these types of knowledge. Experienced teachers may be able to anticipate pupil difficulties and take action to avoid them. The research reported here has been small-scale and exploratory in nature.

Brooks (1984) compared two "expert" experienced teachers with two inexperienced first year teachers. The experienced teachers overlapped seating and information cards and included a separate preview activity. But, both teachers began the class by taking roll. Neither inexperienced teacher did this. All four teachers took role. The two experienced teachers sequenced the activity first. Neither spent much time on the activity. All four teachers positioned the students in assigned or alphabetical seating. The experienced teachers undertook this activity after taking roll. The inexperienced science teacher did it first. The inexperienced math teacher seems to risk, simply by the sequencing, the impression that seating might have been an after-thought. All four teachers elected to introduce the course content or materials. But again, that's where the similarity ended. The two experienced teachers sequenced this activity after roll taking, seating, and rules and procedures. The inexperienced science teacher took roll during rules and procedures. The inexperienced math teacher introduced more course materials a second time after a second round of roll taking and first attempt at a name game. The experienced science teacher spent 55 percent of the class on rules and procedures. The experienced math teacher spent only 11 percent of the class time on the same activity. The inexperienced math teacher's presentation was poorly organized and took a combined total of 23 percent of the class. The verbal transcripts of the inexperienced math teacher and experienced math teacher are dramatically different in organization, verbal behavior and nonverbal behavior.

Brooks (1985) investigated the *first day* of school at the junior high level by videotaping and comparing first-year "brand new" teachers with veteran "superstar" teachers during their first,

second, tenth, and 28th days of school. The resulting videotapes, teacher interviews, and student interviews have left us with a profile of successful junior high school teachers and one dramatic conclusion: a successful first day of school can literally set the stage for a successful school year.

The superstar teachers in our studies shared common practices. They began their classes in a businesslike manner. They checked roll and established seating charts at the same time (overlapping). They minimized the frequency and length of transitions between activities (lag time). They were deliberate and no-nonsense in their explanations of rules and procedures, but smiled when talking about course content and projects. The old adage "Don't smile till Christmas" could probably be modified to "Don't smile during rules and procedures." The superstars maintained direct eye contact with the entire class (scanning). They didn't play name games to acquaint students with one another. Instead, they simply began calling out students' names from the seating charts for questions and answers. The students learned each others' names by listening. We didn't observe any public self-disclosures from students in these teachers' classrooms (such as, "What I did on my summer vacation").

The less successful teachers in our studies also shared common practices. They were slow to begin their classes with any call to order. There was no evidence of "overlapping": thus everything took longer and less was accomplished. The number of transitions was much higher and they lasted longer, thus providing more opportunities for student disruption. These teachers were less clear and persuasive when presenting rules. They used fewer rationales for the rules and spent more time just listing them. Their choices of activities were often questionable. One math teacher had her 8th grade students spend 15 minutes drawing self-portraits! These teachers tended to play name games, quickly resulting in student misbehavior. This preoccupation with individual students dramatically reduced the amount of time these teachers spent scanning the entire class. One teacher smiled only when she explained the consequences for misbehavior, and at no other time during the session! These teachers struggled with their classes the entire year.

Shulman (1985) reported findings from the early stages of a research project whose purpose is to determine the character of teacher subject-matter. Shulman (1985) concluded his preliminary report with the identification of relevant research questions, all having to do with subject matter to be investigated, also "what" and "how" questions.

Shulman (1986) amplified the preceeding paper, emphasizing the importance of subject matter manifesting itself in content of lessons taught, questions asked, and explanations offered; pedagogical content knowledge; curricular knowledge; forms of knowledge, i.e., propositional, case, and strategic, and their embellishment. [Berliner (1986) concluded with a call for professional testing of teachers.]

In the area of teacher planning, Housner & Griffey (1985) compared experienced (five years or more) and inexperienced (preservice) teachers in planning and conducting two lessons in physical education with four elementary school children. In planning, experienced teachers, vis a vis inexperienced teachers, made more decisions concerning strategies for implementation. During interactive teaching, experienced teachers focused on individual student performance while inexperienced teachers focused on the entire class. Experienced teachers' knowledge structures had more, richer, knowledge structures which enabled them to attend to individual differences.

In the area of teacher planning, Griffey & Housner (1985) compared eight elementary physical education teachers with eight preservice elementary teachers. The experienced teachers, not categorized as "expert" teachers: made more information requests; anticipated possible situations; generated contingency plans; made more instructional discussions in the area of management, assessfeedback, demonstrate, focus attention, and equipment use; were more concerned with managing activities during instruction; managing students; manifested more praise and lecturing. Novices made greater use of student ideas, criticizing student behavior, had more

student initiated talk, silence, and confusion, wasted time, lesser focus on the instructional intent of lessons, and more student off-task behavior. In another analysis, of videotapes, experts were more highly structured, showed higher amounts of student cooperation, structuring, student modeling of teacher behavior and pacing, were more aware of individual students, more positive, and less influenced by their students. Overall, experts were more positive and had more structure, and deep structure, with the main differences being in planning, interaction, and student engagement. Novices were more democratic, spontaneous, subject to student manipulation, had more student defiance, were more recursive, abrupt, attended to surface features, and dealt with the class as a whole.

Berliner (1986), in his AERA presidential address, described preliminary aspects of research whose goal is to identify expert pedagogues and also the nature of expertise in pedagogy. Criteria, employed by Berliner and colleagues to identify upper grade level teachers, included reputation, classroom observations, performance in laboratory tasks, and nomination for teaching awards. Vigor in the judging of teachers was conspicuous by its absence, indicated Berliner (1986). Additional problems identified include the confounding of experience and expertise, practice and skill, and identification of the knowledge domains used by expert teachers. Berliner (1986) chose subject matter knowledge and knowledge of organization and management of classrooms as the two main domains used by expert teachers. Preliminary observations from Berliner (1986) include the perception that the expert teachers have acquired a large amount of information, experience, skills, and knowledge. Also, experts make inferences and do not report literally what they see. Also, experts use higher orders of categorization. Experts apparently also make extraordinarily fast and accurate pattern recognitions. Experts are also apparently slower than novices in initial stages of problem solving. (Experts are apparently also sensitive to the task demands and the "social structure" of the job situation. Experts also are seen to be "opportunistic planners" who are quick to change tracks. Experts are also said to show self-regulatory or metacognitive activities not shown by novices.)

Berliner (1986) also concluded that length of experience is necessary to achieve excellence, than an expert's unique knowledge shows up in relation to the goal structure of a problem, and that experts seem to represent problems differently than novices. Also addressed is the "what" and "how" questions.

For an overview of the elements composing Berliner's (previous) perceptions of effective teaching, see Berliner (1985). Included are: a delivered curriculum; allocated time; engaged time; success rate; academic learning time; monitoring; structuring; pacing; questioning; climate factors; tests, and grades; feedback.

A relevant, promising approach is that of attempting to determine the cognitive content of classroom interactions (Greenleaf & Freedman, 1986).

Presage Variables

The only teacher presage variable which relates, and then inconsistently, with effective teaching is teacher verbal ability, clarity (Coleman, et al. 1966; Hanushek, 1970). Teacher enthusiasm also sometimes correlates with teaching effectiveness.

Qualities of Excellent, Ideal, Liked, Effective Teachers

Initially examined will be the literature of students' opinions concerning effective-ineffective, best-worst, liked-disliked, ideal, etc., teachers.

Characteristics common to this literature (Follman, November 15, 1985), in very approximate rank order, are teachers':

knowledge of subject matter
communication ability
pleasing personality
interest in students
encourages classroom participation
stimulation of interest
fairness
organization, preparation
enthusiasm for subject
sense of humor
encourages independent thinking

Correlational and Factor Analytic Literature

In the factor analytic literature the Ryans (19xx) public school level factors of competence, and empathy, particularly, have held up reasonably well.

Incompetent Teachers

Bridges (1986) conducted a survey of the methods used in California public schools to deal with incompetent teachers. One interesting finding was that in the 141 participating California school districts over a two-year period, there were 232 dismissals for incompetence, ca. .6 of 1% of the total teachers. Temporary teachers, ca. 7% of the California teaching force, accounted for nearly 70% of the dismissals.

Bridges (1986) concluded that incompetence appeared to represent persistent failure in one or more of the following to:

1. maintain discipline
2. treat students properly
3. impart subject matter
4. accept teaching advice from superiors
5. demonstrate mastery of the subject matter
6. produce the intended or desired results in the classroom.

The most common failure was in maintaining discipline. Also incompetency showed up in a pattern of recurring instances, not one single egregious incident.

Summary, Synthesis, Overview

It is concluded that there are substantial overlaps between the characteristics of experts vs. novices in cognitive psychology and experts vs. novices in pedagogy. These include the following variables: possession of larger amounts of information and knowledge, demonstration of automatization of central processes, and especially routines; and superiority in achieving criteria especially involving meaningful material. Lesser overlaps include: higher levels of abstraction; construction of more complex schema; speed of activity; flexibility; and chunking. Some of these lesser overlaps probably appear less than they actually are because of both the inadequacy and also the limited amount, of the expert-novice pedagogy research.

Other areas of expert pedagogy include: teacher verbal ability, and possibly enthusiasm; the factors of competence and empathy; and a spread of teacher qualities including knowledge of subject matter, communication ability, pleasing personality, interest in students, stimulation of student interest, encouragement of student participation, fairness, sense of humor, and encouragement of independent thinking. The incompetent teacher literature was generally consistent with these characteristics although there was a substantial emphasis on the negative side i.e., discipline problems.

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